SOCRATES 2.0
FAST SAFE GREEN

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REPORT

SOCRATES2.0 Final Evaluation

Jaap Groenendijk (TwynstraGudde)
Martijn de Kievit (Goudappel)
Eline van Min (TwynstraGudde)
Martin van Oosten (Arup)

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Evaluation team
Jaap Groenendijk (TwynstraGudde)
Martijn de Kievit (Goudappel)
Eline van Min (TwynstraGudde)
Martin van Oosten (Arup)

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1. Introduction

New, smart solutions for mobility in urban regions by the deployment of interactive traffic management. That is SOCRATES$^{2.0}$ in a sense. This report contains the results of the final evaluation.

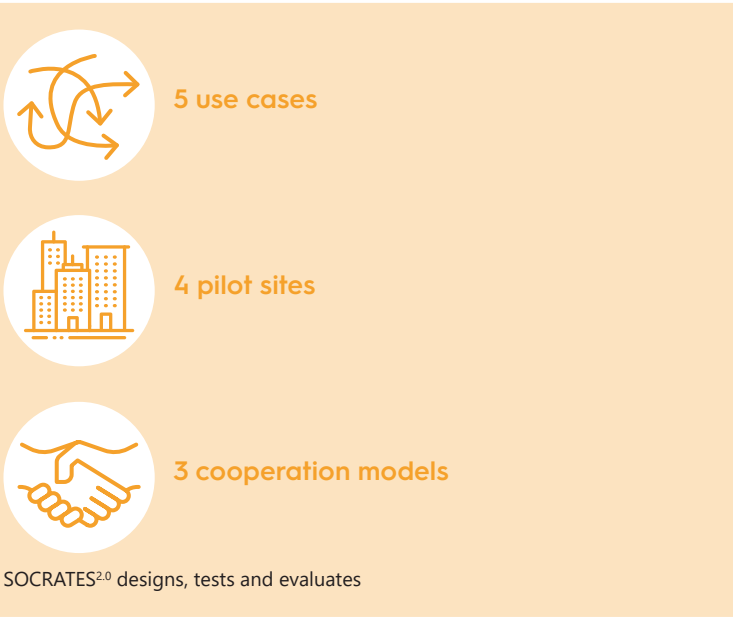
1.1 SOCRATES$^{2.0}$

SOCRATES$^{2.0}$ is a European project that brings together road authorities, automotive industry and data- and service providers around the future of interactive traffic management. Together they set new standards to make systems in-car and at the roadside to work together. This enables effective traffic management and opens doors to innovative traffic information and navigation services. The purpose is to make traffic smoother, safer and more sustainable, in accordance with the recent European *Sustainable and Smart Mobility Strategy*.

The challenge is not only the technical realisation but also the cooperation resulting in impact on the road. For a well-structured cooperation between road authorities, automotive industry and data- and service providers, a new cooperation framework has been created in SOCRATES$^{2.0}$. So, SOCRATES$^{2.0}$ promotes a continuous deployment of European-wide interactive traffic management. It designs, deploys and evaluates (goals):

- New and extended traffic management measures and in-car services for road users.
- A cooperation framework for interactive traffic management among road authorities, automotive industry and data- and service providers.

Five different use cases have been designed in SOCRATES$^{2.0}$: network optimisation, smart destination, environmental zone information, lane information and road works[1]. This is to test to which extent the cooperation framework enables the deployment of interactive traffic management and whether innovation traffic information and navigation services are indeed emerging. Testing has been done in four pilot sites in different European countries: Amsterdam region, Antwerp region, Copenhagen region and Munich region.



SOCRATES$^{2.0}$ designs, tests and evaluates

The coronavirus pandemic has also had an influence on SOCRATES$^{2.0}$. Due to the corona measures taken by the governments, there was less traffic (resulting in almost no congestion) and no large-scale events during testing. Therefore, not all tests have been performed as planned. For the evaluation, this means there are mainly limitations for evaluating the functional performance. Yet a lot of knowledge has been gained.

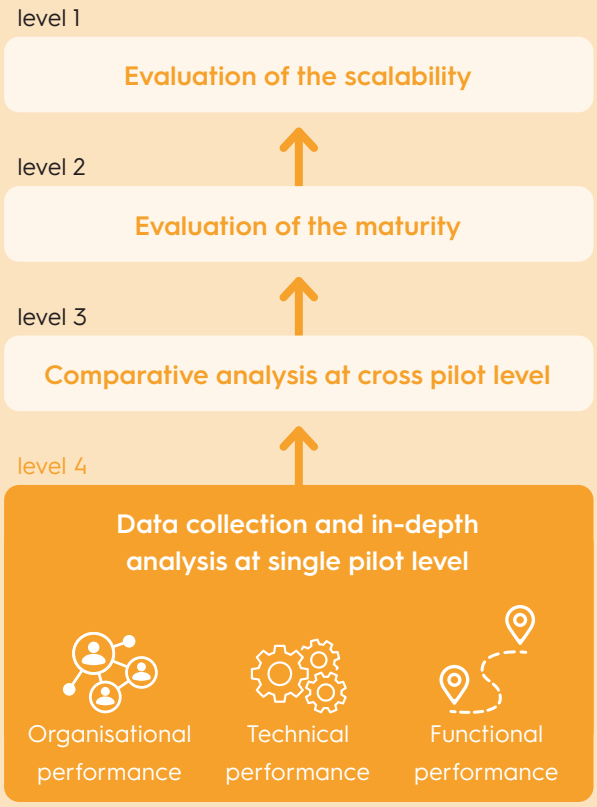
1.2 Evaluation SOCRATES$^{2.0}$

The evaluation is intended to provide insight into and learn from the facts and experiences about the deployment of interactive traffic management, gained in SOCRATES$^{2.0}$. The main evaluation goals are:

- To contribute to the creation of a common framework for the cooperation and agreements between road authorities, automotive industry and data- and service providers.
- To learn about the feasibility and the usefulness for future large scale implementation of interactive traffic management.
- To learn how interactive traffic management can be deployed, based on the interaction between public traffic management centres and private back offices.
- To learn about the public acceptance of new and extended traffic management measures and in-car services for road users, and their actual effects on traffic performance.
- To contribute to the creation of a generic solution for the exchange protocol for traffic management related information between public traffic management centres and private back offices.

[1] The use cases refer to the services mentioned in the *Grant Agreement*: smart routing, actual speed and lane advice, local information and hazardous warnings, and improved roadside traffic management measures.

Based on these evaluation goals, the relevant evaluation aspects and expectations were further specified in an ex-ante evaluation. Four levels were then distinguished for the ex-post evaluation (see figure below). First, an analysis was made of the organisational-, technical and functional performance for each of the pilot sites (level 4)[2]. Subsequently, this report is about the comparative analysis at cross pilot level and the ex-post evaluation of the maturity and scalability (level 3, 2 and 1 respectively).



Four levels ex-post evaluation SOCRATES[2.0]

For the ex-post evaluation an evaluation plan has been drawn up. Part of this plan is the definition of so-called SOCRATES[2.0] users and evaluation users. SOCRATES[2.0] users are road users who receive information and/or advice from SOCRATES[2.0]. Evaluation users – a subset of SOCRATES[2.0] users – are road users who actively and knowingly participate in the ex-post evaluation at single pilot level for example by filling out questionnaires about their experiences. In order to properly align the evaluation with the progress of the project, agreements have been made about the evaluation plan and its execution. During the execution, the state of affairs was regularly discussed with the supervisory group and presented in the SOCRATES[2.0] Plenaries.

Facts and experiences have been collected for, in first instance, the analysis of the organisational-, technical and functional performance for each of the pilot sites and in second instance also the ex-post evaluation of the maturity and scalability. Facts and experiences have been collected through a desk research, 40 in-depth interviews with the activity leaders and each of the partners (in two rounds), questionnaires completed by the evaluation users, and also through logbooks and data made available by the partners with regard to the technical and functional performance[3]. Interim findings and analyses were presented during the SOCRATES[2.0] Plenaries.

Facts and experiences have been analysed at (cross) pilot level and united into a coherent picture. To evaluate the maturity and scalability, an evaluation session was organised during a SOCRATES[2.0] Plenary, in which the maturity and scalability was mapped out with all partners and discussed extensively. The findings have been described in this report. A draft report has been discussed with the with the supervisory group and submitted to the partners involved (check on factual correctness). The comments have been processed. Subsequently, the draft report has been discussed again with the supervisory group. After that, the report has been finalised.

[2] The aspects evaluated in the organisational performance are the cooperation (framework) and the role of the road authorities and the automotive industry/service providers. This has been done by TwynstraGudde. The aspects evaluated in the technical performance are the technical conduct and the data management and quality. This has been done by Arup. The aspects evaluated in the functional performance are the user acceptance and the traffic effectiveness. This has been done by Goudappel.

[3] On the basis of a data plan with an overview of the required data, agreements have been made with each of the partners about making these data available.

1.3 This report

This report contains the results of three and a half years of intensive public-private cooperation on the deployment of interactive traffic management. The fastest way to learn the results is to read chapter 5. This chapter presents the conclusions and lessons learnt, also in terms of scalability. Possibly in combination with chapter 2, which introduces SOCRATES$^{2.0}$ in more detail and summarises the characteristics of and main insights gained in each of the four pilot sites. However, for a complete overview of the results, read the report cover to cover. Chapter 3 contains the results of a comparative analysis of the experiences with the deployment of interactive traffic management at cross pilot level with regard to the organisational-, technical- and functional performance. Chapter 4 then provides an answer to the question to what extent the concept of interactive traffic management as designed and tested in SOCRATES$^{2.0}$ is already mature enough to be really deployed.

2. Designing and testing in four pilot sites

This chapter introduces SOCRATES$^{2.0}$ in more detail and summarises the characteristics of and main insights gained in each of the four pilot sites. The pilot sites are presented in reverse alphabetical order, so that the insights build on each nicely.

2.1 Introduction SOCRATES$^{2.0}$ in more detail

Public-private cooperation is necessary to move forward

'*There is little room for manoeuvre to improve. New élan in the field of traffic management is only possible if public and private parties work together equally*, an interviewee summarises the reason for SOCRATES$^{2.0}$ in a sense. SOCRATES$^{2.0}$ brings together road authorities, automotive industry and data- and service providers around the future of interactive traffic management. As stated in chapter 1, this enables effective traffic management and opens doors to innovative traffic information and navigation services. The challenge is not only the technical realisation but also the shape of a well-structured cooperation. SOCRATES$^{2.0}$ is based on an equal public-private partnership.

The cooperation within the project has been experienced very positively by the partners. Public and private parties have come to understand each other's perspective better. And each has been able to contribute from their own perspective. *'It's an enthusiastic and interested group of people. Together we have been able to take an important step forward'*, an interviewee says appealing.

Cooperation framework to enable interactive traffic management

For a well-structured cooperation between road authorities, automotive industry and data- and service providers, a new cooperation framework has been created in SOCRATES$^{2.0}$. It consists of three cooperation models supported by four so-called intermediary roles. The three cooperation models – *exchanged data, shared view* and *coordinated approach* – build on each other. The more complex the form of cooperation, the more the need for facilitating functions, performed by the intermediary roles. So, these intermediary roles – *network monitor, strategy table, network manager* and *assessor* – enable the interaction between road authorities, automotive industry and data- and service providers.

A separate publication is available in which the cooperation framework is explained in more detail. This report contains an extensive description of the experiences with the cooperation framework in practice as well as an evaluation of its maturity.

DATEX II standard used for the exchange of traffic management related information

Smooth data exchange is a precondition for deploying interactive traffic management. Within SOCRATES$^{2.0}$ DATEX II has been used as a standard for the exchange of traffic related information. The exchange of traffic related information is not new and DATEX II has also existed as a standard for some time now. However, a smooth data exchange is not always self-evident. The key lies in creating a generic solution for intelligent ways to collect, exchange and use data throughout the entire traffic information and navigation services value chain (standardisation).

What's in a name?

'That's a nice story', said one of the initiators of SOCRATES$^{2.0}$, the late Fred Zijderhand, when asked where the name SOCRATES$^{2.0}$ comes from. *'In 1998 I was involved in the SOCRATES project, which was of course not called '1.0' at the time.'* In that project, the automotive industry, telecom providers and road authorities have worked together on the basis for including service messages in the static maps of the then new systems in-car. *'This later resulted in the service providers as we know them today. In that sense, SOCRATES$^{2.0}$ is the next step.'*

According to Fred Zijderhand, the SOCRATES project shows that a completely new system is not switched on all at once. *'We learn a lot from projects and pilots. But major changes take place step by step. The best ideas from the projects and pilots of the past decades are now finding their way to wide application in practice.'*

Various parties, each with their own history, interest and reasons for participating in SOCRATES[2.0]

Finally, a note on the partners involved in SOCRATES[2.0]. It is important to realise that various parties participate. (During the project, there were also some changes in the roles of the partners). There are (major) differences both within public and private parties and between public and private parties. Road authorities and the automotive industry/service providers each have their own history, interests and reasons for participating in SOCRATES[2.0]. Varying from gaining insight into the needs of the automotive industry/service providers, through learning about road users' follow-up behaviour to finding new ways of cooperation. In general, road authorities naturally think in terms of the scale of their own region and solutions to problems on their road network (system optimum for road users in general). While the automotive industry/service providers naturally think in terms of scalability and the best information and fastest/most comfortable route for their individual users. It is also important to realise that the use base and business case of individual private parties may differ substantially, as the perceived role and responsibilities of road authorities.

2.2 Pilot site Munich

Straightforward and focused on using existing traffic information. That is what characterises pilot site Munich. Both the Bavarian Road Authority, as an associated partner, and various private partners (Be-Mobile, BMW, BrandMKRS, HERE Technologies, MAPtm and TomTom) are involved. Two use cases have been designed and tested in the Munich region:

- *Smart destination*, with the purpose of making traffic management strategies for events in the Allianz Arena and Messe München available to the automotive industry/service providers, in the expectation that they will take these strategies into account in their navigation services. Cooperation model *exchanged data* has been chosen for this use case.
  The smart destination use case has only been tested in some technical tests and in a field test with some so-called friendly users due to the corona measures. These tests have been successful and relevant insights have been gained into the interaction between making (existing) public traffic information available and using this information by the automotive industry/service providers.
- *Road works*, with the purpose of creating better insight into road works within the Munich region by merging public and private data. Cooperation model *shared view* has been chosen for this use case. The use case is more or less comparable to the one in pilot sites Amsterdam and Copenhagen.
  The road works use case was tested in the period January 2020 to December 2020. It has become clear that there is a need for (further) technical development. In theory, road works has potential of a quality leap – the testing shows that there is limited overlap between the public and private data, which indicates that a new multi public-private data feed enriches the insight into road works in the Munich region – in practice that potential cannot be confirmed yet.

Main insights pilot site Munich

1. Making public traffic management strategies available is a first step towards interactive traffic management. It is important for the automotive industry/service providers to know the cause of the activation of a traffic management strategy (insight into the reasons why). The cooperation model *exchanged data* is effective in itself.
2. The availability of data such as public traffic management strategies is no guarantee that the automotive industry/service providers, although open minded, will take these strategies into account in their navigation services. For that, a more advanced cooperation model may be desirable and the win-win-win must be further elaborated.
3. The usage of standards should not be underestimated. Although DATEX II is a European standard for data exchange, there is still a lot of ambiguity and miscommunication possible.
4. Some form of a national access point is a precondition for the easy use of available data by a wider range of the automotive industry/service providers and thus for scalability of interactive traffic management.

2.3 Pilot site Copenhagen

The multimodal nature of the use cases, but also a lot of work to be done to realise that ambition. That is what characterises pilot site Copenhagen. Both the City of Copenhagen, as an associated partner, and various private partners (BrandMKRS, Technolution and TomTom) are involved.

Three use cases have been designed and tested in the Copenhagen region:

- *Network optimisation / environmental zone information (combined)*, with the purpose of optimising network traffic flow based on multiple modalities (cars and bicycles) and air quality, in accordance with the policy goals of the City of Copenhagen. Cooperation model *shared view* with an additional network manager role was initially chosen for these use cases.
  The network optimisation uses case was tested in the period September 2020 to December 2020. The environmental zone use case was ready for testing from November 2020. So, these use cases have only been tested to a limited extent in real life traffic. However, relevant insights have been gained into the opportunities of combining interactive traffic management with a multimodal approach.
- *Smart destination*, with the purpose of increasing the experience of visitors to events in the Parken stadium (and Royal Arena) by advising them (for the last part of their trip) to take public transport and/or to show them a parking area. Cooperation model *shared view* with an additional network manager role was initially chosen for this use case.
  The smart destination use case has only been tested in a technical test due to the corona measures. This test has been successful.

Main insights pilot site Copenhagen

1. Interactive traffic management can also be (technically) combined with a multimodal approach (multiple modalities and air quality). This is very interesting with a view to the future.
2. Aligning public investments in a multimodal traffic management approach – traffic management in the Copenhagen region is still at the beginning – with the possibilities offered by private parties is important.
3. Coordinating services by both road authorities and automotive industry/service providers requires some form of coordination at strategic level. This can also be organised pragmatically.

2.4 Pilot site Antwerp

Really trying to find new ideas, such as a toll-free voucher, and new ways of cooperation. That is what characterises pilot site Antwerp. Both the Flemish traffic centre and various private partners (Be-Mobile, BMW, BrandMKRS, HERE Technologies, MAPtm and TomTom) are involved.

Three use cases have been designed and tested in the Antwerp region:

- *Network optimisation (two variants)*, with the purpose of advising specific road users to switch routes when toll is suspended of reduced on the motorway network in order to improve the network performance. Cooperation models *exchanged data* and *shared view* with an additional network manager role were initially chosen for this use case.

The network optimisation use case was tested in the period October 2019 to December 2020. Relevant insights have been gained into the added value of improved information when toll is suspended and the opportunities to optimise network traffic flow over the river crossings by offering a toll-free voucher as an incentive te reroute.

- *Lane information*, with the purpose of bringing lane information in-car. Cooperation model *exchanged data* has been chosen for this use case.
  The lane information use case was also tested in the period October 2019 to December 2020. Relevant insights have been gained into the added value of bringing the actual state of the lane control system in-car.
- *Road works*, with the purpose of creating better insight into road works within the Antwerp region by merging public and private data. Cooperation model *shared view* has been chosen for this use case. See further the Munich region.

Main insights pilot site Antwerp

1. The deployment of straightforward use cases in which the emphasis is on bringing information in-car – think of toll information and lane information – is already very well possible.
2. An interesting first step has been taken towards a future in which public and private parties jointly contribute to the goal of optimising network traffic flow. By stimulating road users in the right way, interesting new potential seems to arise.
3. Road users are willing to change their behaviour even accepting a certain addition of their travel time.
4. The need for an assessor role in a use case such as network optimisation seems to arise naturally. At least when it is important to jointly assess the performance of the end-user services and reward the contribution of each of the public and private parties.

2.5 Pilot site Amsterdam

Ambitious in the coordinated activation of service requests to both traffic management centres and the automotive industry/service providers, but also complex. That is what characterises pilot site Amsterdam. Both public road authorities in the region (Rijkswaterstaat, province of North-Holland, City of Amsterdam and the National Road Traffic Data Portal NDW) and various private partners (Be-Mobile, BMW, BrandMKRS, HERE Technologies, MAPtm, Technolution and TomTom) are involved.

Four use cases have been designed and tested in the Amsterdam region:

- *Network optimisation*, with the purpose of optimising network traffic flow by coordinating the services by both road authorities and service providers. Cooperation model *coordinated approach* has been chosen for this use case.
  The network optimisation use case was tested in the period December 2019 to December 2020[4]. Relevant insights have been gained into opportunities of advising and rerouting specific road users.
- *Smart destination*, with the purpose of increasing the experience of event visitors to ArenAPoort by optimising traffic flow distribution over space and time using optimised parking. Cooperation model *coordinated approach* has been chosen for this use case.
  The smart destination use case has only been tested in some technical tests and in a field test with some so-called friendly users due to the corona measures. These tests have been successful and relevant insights have been gained into the opportunities of using optimised parking.

[4] Initially, there was only one end-user service available. The other end-user services were available from September/October 2020.

- *Environmental zone information*, with the purpose of providing better traffic information for truck- and coach drivers by bringing environmental zone information in-car. Cooperation model *exchanged data* has been chosen for this use case.
  The environmental zone use case was tested in the period November 2019 to December 2020. Relevant insights have been gained into the possibilities of bringing both static and dynamic environmental zone information in-car.
- *Road works*, with the purpose of creating better insight into road works within the Munich region by merging public and private data. Cooperation model *shared view* has been chosen for this use case. See further the Munich region.

Main insights pilot site Amsterdam

1. The deployment of the more or less straightforward environmental zone information use case is possible in itself. Testing this use case has underlined important conditions for future large-scale implementation (for multiple use cases): standardisation of traffic related information, scalable change processes and sufficient road users for whom the end-user service is interesting.
2. An interesting next step has been taken towards a future in which public and private parties jointly contribute to the goal of optimising network traffic flow, by advising and rerouting specific road users. A foundation has been laid for the coordinated distribution of service requests to both traffic management centres and the automotive industry/service providers.
3. It is misconception to think that when road authorities make data available, the automotive industry/service providers will automatically use these data. Road authorities have to engage in some form of cooperation with the automotive industry/service providers, each making their own decisions. So, a *coordinated approach* enables interactive traffic management.
4. Service providers highly trust on the quality of their own route-engines (algorithms). So, they prefer service requests that allow the usage of their own route-engines rather than service requests that prescribe a route to be followed.
5. Road users tend to trust the automotive industry/service providers more than road authorities when advised to reroute. Nevertheless, road users also appreciated the existing information at the roadside.
6. Despite the fact the automotive industry/ service providers can reach a large number of road users, the number of road users that can be rerouted is much lower. For actual realise impact on the road it is essential that a large userbase is available. In particular when a larger and complex network, such as in the Amsterdam region, is considered.
7. There must be dynamism in the interaction between the intermediary roles. In particular, the interaction between the strategy table and the assessor role requires attention with a view to making adjustments based on reports by the assessor about the key performance indicators.

3. Findings on cross pilot level

As stated in the previous chapter, various meaningful experiences have been gained with the deployment of interactive traffic management in each of the four pilot sites. This chapter contains the results of a comparative analysis of these experiences at cross pilot level with regard to the organisational-, technical- and functional performance.

3.1 Analysis organisational performance

Cooperation models

As explained in chapter 2, a new cooperation framework consisting of three cooperation models and four supporting intermediary roles has been created in SOCRATES[2.0]. In each of the four pilot sites, experience has been gained with one or more cooperation models.

Choice for cooperation models is determined by type of use cases and regional context

The comparative analysis at cross pilot level shows that the choice for a cooperation model is not only determined by the type of use cases[5], but also by the regional context (starting position; think of systems currently in operation). In general, the following relationship can be seen between the appropriateness of a cooperation model and the type of use cases (see the following for further explanation):

- Cooperation model *exchanged data*, is especially appropriate for the type of use cases in which the emphasis is on bringing traffic information in-car (for example bringing environmental zone information, lane information and/or toll information in-car).
- Cooperation model *shared view,* is especially appropriate for the type of use cases in which the emphasis is on jointly improving traffic information by merging public and private data in order to create a common truth (for example improving road works information).
- Cooperation model *coordinated approach*, is especially appropriate for the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/service providers to increase impact (for example network optimisation and smart destination).

At the same time, experience shows that the initial choice for the cooperation models in the four pilot sites may have been even more determined by the regional context. So, 20% of the partners indicate this is the most important factor[6] and another 60% of the partners indicate this is an important factor, as is the type of use cases (proposition scored by partners during the evaluation session).

In the Amsterdam region, the choice for the cooperation models has been made consciously. The choice is mainly determined by the high ambition – with high expectations about the pursuit of common goals in public-private partnerships, especially among public parties – and the cooperation already built up in Practical Trial Amsterdam. In the Antwerp region, the choice for the cooperation models has been made in a more organic way. Designing the use cases has gone hand in hand with the creation of the cooperation framework. The regional context is partly determining in the sense of room for experimentation and a hands-on mentality. In the Copenhagen region, the choice for the cooperation models has been made in a more pragmatic way. The choice is mainly determined by the regional context; traffic management in Copenhagen is still at the beginning and the City of Copenhagen has had limited resources to participate in SOCRATES[2.0]. And in the Munich region, the choice for the cooperation models also has been made in a more pragmatic way. The choice is mainly determined by the regional context; the focus has been mainly on using existing traffic information by involving private service providers. And within each of these pilot sites, the regional context also plays a role in the sense that managing the urban road network presents different challenges (multiple modalities, multiple systems at the roadside, and so on) than managing the main road network.

The regional context enables and limits at the same time. This can be seen, for example, in the smart destination use case for which different cooperation models have been initially chosen in the different pilot sites. A *coordinated approach* in the Amsterdam region has mainly been possible due to a favourable starting position, created in, among other things, Practical Trial Amsterdam: a well-coordinated operational partnership of the partners in ArenAPoort and a complete set of systems currently in operation. At the same time, the starting position is also limiting here: it has required customisation, which makes scaling up more difficult anyway.

[5] The type of use cases is related, among other things, to the ambition and expected impact to be generated.

[6] It also explains why public-private partnerships vary from one pilot site to the other.

Cooperation model exchanged data is appropriate and effective for bringing traffic information in-car

The cooperation model *exchanged data* has been chosen in different pilot site / use case combinations (see table below). Experience shows that this cooperation model is appropriate and effective for the type of use cases in which the emphasis is on bringing traffic information in-car. Data exchange is not that new either, although it is embedded in a public-private partnership within SOCRATES[2.0]. It is not just about making data available, but mainly about making agreements with each other about the desired data and to some extent the actual use of that data. In the use cases as designed and tested in SOCRATES[2.0], there were limited changes in the road authorities'- and automotive industry/service providers' role[7]. The end-user services give the opportunity to reach more road users (extra information channel, consistent information). If it is not an existing data feed, the biggest change for road authorities is to make the data available in a machine readable way. And if necessary, to adapt these data to the needs of the automotive industry/service providers, of which the smart destination use case in the Munich region is a good example. The Bavarian Road Administration has extended the data feeds with the cause of a traffic management strategy (insight into the reasons why) and a strategy-ID. An important question for most automotive industry/service providers is whether an end-user service can also be easily implemented European wide.

An important comment to the effectiveness of the cooperation model *exchanged data* for the smart destination use case, as chosen in the Munich region, is that this cooperation model does not guarantee that the automotive industry/service providers will actually take the public traffic management strategies for specific events into account in the navigation services[8]. In general, a more advanced cooperation model may be more desirable for that (just like a public-private business model).

The cooperation model *exchanged data* has no new supporting intermediary roles[9]. This is correct, but experience also shows that the role of a national access point must be related to the cooperation framework (applicable to all cooperation models). Making traffic information available through a national access point, such as in the Amsterdam region and Munich region, has the great advantage that a wider range of automotive industry/service providers could also use the data feeds relatively easy in the future. Some partners also view the National Road Traffic Data Portal NDW in the environmental zone information use case in the Amsterdam region as a kind of network monitor and prefer to call it a *shared view 'light'*. The term light refers to the fact that the data are gathered from only one data provider (City of Amsterdam). The advantage of adding the network monitor is that the environmental zone information has been made available in DATEX II.

Pilot site	Use case	Any particularities
Amsterdam region	Environmental zone information	Environmental zone information is made available through the National Road Traffic Data Portal NDW (national access point)
Antwerp region	Network optimisation (variant I, idea of improved information when toll is suspended) Lane information	In addition, toll suspension message from the Flemish traffic centre is forwarded by an intermediary
Munich region	Smart destination (making public traffic management strategies for specific events available)	Public traffic management strategies are made available through the National Access Point MDM

Choice for cooperation model exchanged data

[7] An exception is when the end-user service is a completely new service for a service provider, such as in the Antwerp region for the network optimisation use case (variant I) for one of the service providers involved. For this service provider the limited number of toll suspension messages has been reason to stop shortly after designing and building the service.

[8] Within SOCRATES[2.0] the automotive industry/service providers were open-minded. During the technical tests in pilot site Munich, it was no problem to accept recommended routes even if these routes were not the shortest one, as long as the reasons why to take these routes were clear.

[9] The intermediary in the network optimisation use case in the Antwerp region functions well in itself, but is not a conditio sine que non. It is more a pragmatic choice, prompted by the intermediary roles in the other variant of this use case. The idea is that the Flemish traffic centre will send the toll suspension message directly to the service provider if the end-user service continues beyond SOCRATES[2.0].

Cooperation model shared view is appropriate for jointly improving traffic information by merging public and private data in order to create a common truth

The cooperation model *shared view* has been chosen in different pilot site / use case combinations (see table below). Experience shows that this cooperation model is appropriate for the type of use cases in which the emphasis is on jointly improving traffic information by merging public and private data in order to create a common truth, such as road works. Although its effectiveness cannot yet be properly assessed based on the results of testing road works[10], there are strong indications that a *shared view* could be effective. It has proven that it is possible to exchange data, also between competing private data providers. And the limited overlap between the various public and private data sources of road works information indicates that a new multi public-private data feed enriches the insight for each of the partners. In the road work use case as designed and tested in SOCRATES[2.0], there were also limited changes in the road authorities' role or it had to be an update of its own data source of road works information. The most important change for the service providers' role was sharing data with competing data providers.

Experience also shows that the cooperation model *shared view* is suboptimal for the type of use cases in which the emphasis is on coordinating the services by both road authorities and automotive industry/service providers, such as network optimisation and smart destination. When the aim is to realise that level of coordination, a more advanced cooperation model is desirable. That is why for the use case network optimisation (variant II) in the Antwerp region and the use cases network optimisation and smart destination in the Copenhagen region, where a *shared view* was initially chosen, elements of a *coordinated approach* also have been used (see the following).

The cooperation model *shared view* has one associated intermediary role, the network monitor. Experiences show that the network monitor role – designed as an independent third party *without* its own end-user services – is a conditio sine qua non for the willingness of data providers to share their data. A private party with its own end-user services is not trusted. At the same time, when looking at the potential of road works, there still appears to be some hesitation in sharing data (for free) for competitive reasons. *'My impression is that jointly improving traffic information still has some boundaries if it comes to sharing data with competitors'*, an interviewee explains.

Pilot site	Use case	Any particularities
Amsterdam region	Road works	Trusted third party fills network monitor role
Antwerp region	Road works	Trusted third party fills network monitor role
Munich region	Road works	Trusted third party fills network monitor role

Choice for cooperation model shared view

[10] The new multi public-private data feed is still difficult to interpret, let alone assess its quality. And there is no feedback loop on the quality of the road works information. In the eyes of a number of partners this is why there is no shared view yet.

Cooperation model coordinated approach is appropriate and to some extent necessary for coordinating services by both road authorities and automotive industry/service providers to increase impact

The cooperation model *coordinated approach* was initially only chosen in the Amsterdam region. Although the ex-post evaluation shows that elements of the *coordinated approach* also have been used in the Antwerp region and Copenhagen region. So in the end a coordinated approach was more or less chosen as well (see table below). Experience shows that this cooperation model is appropriate and to some extent necessary for the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/service providers to increase impact. It is the most advanced cooperation model and, when fully applied, such as for the network optimisation use case in the Amsterdam region, also quite complex. Gaining more experience is necessary to be able to apply a *coordinated approach* effectively. At the same time, the other pilot site / use case combinations show that it is not necessary to always fully apply this cooperation model; functions can also be filled in a more pragmatic way. In the use cases as designed and tested in SOCRATES$^{2.0}$, the most important change for the road authorities' role was ultimately to achieve alignment with the automotive industry/service providers. Then the end-user services give additional opportunities to optimise network traffic flow and to enhance the experience of event visitors. Another important change was that traffic management centres had to trust that someone else – the network manager – requested for traffic management measures to be taken[11]. How to handle the various service requests has been a challenge, taking into account the workload of the operators.

The most important change for the automotive industry/ service providers' role was how (far) they can/want to contribute to the goal of optimising network traffic flow or enhancing the experience of event visitors.

The cooperation model *coordinated approach* has four associated intermediary roles, although they are not always fully filled in the use cases as designed and tested in SOCRATES$^{2.0}$ (see the following for the experiences). Interestingly, even if the roles of the strategy table and the assessor were not foreseen in the pilot design, the need for these functions grew organically during testing to some extent.

Pilot site	Use case	Any particularities
Amsterdam region	Network optimisation Smart destination	- Strategy table has been filled pragmatically, assessor role has not yet been defined[12]
Antwerp region	Network optimisation (variant II, idea in which road users get a toll reduction when they reroute)	Strategy table has been organised informally and pragmatically, need for an assessor has grown organically
Copenhagen region	Network optimisation / environmental zone information Smart destination	Strategy table has been organised pragmatically, no assessor role

Choice for cooperation model coordinated approach

[11] For the Copenhagen region, the traffic management centre still has insufficient options to follow up service requests from the network manager.

[12] Ultimately, no assessor role was implemented in the smart destination use case in the Amsterdam region, partly because it has not been possible to test this use case in real life traffic. But whether an assessor role is needed or whether the assessment can be embedded in the evaluation after en event has not yet been defined.

Intermediary roles

Understanding the characteristics of each of the intermediary roles

The comparative analysis at cross pilot level sheds more light upon the characteristics of each of the intermediary roles (see table below). There is already a fairly complete picture of the tasks and responsibilities, and the relationships. However, the picture of the preconditions to act and the margins to act within is less complete.

In addition, important experience has been gained on the interpretation of the intermediary roles, in particular:

- *Network monitor*; trust in the network manager is important in the sense that public and private parties must be willing to share their data with the network monitor. This often means that not all partners can fill this function. In particular the road works use case has made this very clear; a private party with its own end-user services is not trusted in this role. Trust also plays a role in another way. What is striking is that the partners tend to trust their own data more than to use the (merged and completed) view of the current traffic state created by the network monitor. However, the network manager does use the view of this current traffic state.
- *Strategy table*; a distinction can be made between the initiation phase in which the function of the strategy table is mainly to find and define common goals and key performance indicators (*'making agreements on a joined network strategy and toolbox'*), and the deployment phase in which the function of the strategy table is mainly to make adjustments based on reports by the assessor about the key performance indicators. Experience shows that the first function can sometimes also be organised (more) informally and pragmatically.
- *Assessor*; neutrality of the assessor who assesses the impact of both the automotive industry/service providers and traffic management centres is important, especially if money – for example as a reward for generated impact – is involved (in the future). Obtaining data to measure performance is still a challenge.

In general, it is important that public and private parties must trust that the network monitor, network manager and assessor to fill their role as agreed at the strategy table. The initiation phase is also important in this respect, in order to build trust and set up the rules of the game.

	Network monitor	Strategy table	Network manager	Assessor
Tasks and responsibilities	Automatic collection, merging and completion of data Defining view of current and predicted traffic state	Finding and defining and common goals and key performance indicators Developing toolbox Making adjustments (monitoring)	Filling toolbox (measures) Defining view of problem state Automatic activating service requests	Monitoring, assessing and feedback of performance Objectifying cooperation
Relationships	Public and private data providers *Network manager, but also assessor*	Participants are road authorities and automotive industry/ service providers *Assessor*	Both automotive industry/ service providers and traffic management centres *Network monitor and strategy table, but also assessor*	Both automotive industry/ service providers and traffic management centres *Strategy table, but also network monitor and -manager*
Preconditions to act	Reliability view of traffic state Willingness of parties to share data	Dialogue and decision making capability Mandate of participants	Quality and explainable service requests Willingness of parties to follow up on service requests	Neutrality and auditable Possibilities to measure performance
Margins to act within	Little or no; supply role	Quite a lot within the region (within mandate)	Guided by strategy table	Little or no; objective role

Characteristics intermediary roles summarised

Interaction between the intermediary roles is just as important

It is of course important that the (individual) intermediary roles are properly filled (tasks and responsibilities, and so on). However, experience shows that the interaction between the roles may even more determine the effectiveness of the cooperation. In particular, the dynamics in the following relationships are important:

- N*etwork monitor and network manager*; in order to define effective measures, the network manager uses the view of the current- and, if available, the predicted traffic state created by the network monitor. So, the dynamics in this relationship seem self-evident. Sometimes the network monitor- and network manager role are also filled by one party (see the following).
- *Strategy table and assessor*; although in none of the use cases it was possible to fully test the interaction between the strategy table and the assessor (feedback loop), the dynamics in this relationship seem to be essential for the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/ service providers (for example network optimisation and smart destination). '*We have not been able to test the dynamics between the strategy table and the assessor. That's frustrating. These dynamics are essential, I think; what is the generated impact, can we make adjustments to increase the impact, and so on?*', an interviewee says appealing.

Not always sensible to combine intermediary roles

In some pilot site / use case combinations several intermediary roles have been filled by one party (see table below). Combinations that have occurred are: network monitor & strategy table, network monitor & network manager, strategy table & assessor, and network manager & assessor. These combinations have sometimes arisen pragmatically rather than consciously chosen. However, experience shows that, in view of the desired neutrality, it is not always sensible to combine the assessor role with another one. This does not alter the fact that it is more important that the assessor does not provide end-user services itself. And of course there is an important relationship with the strategy table. Based on the experiences so far, no statements can be made about the extent to which it is sensible to combine the network monitor with other roles.

Pilot site / use case combination	Combinations of intermediary roles
Amsterdam network optimisation	Network monitor & strategy table Strategy table & assessor
Amsterdam smart destination	Network monitor & network manager
Antwerp network optimisation	Network manager & assessor
Copenhagen network optimisation / environmental zone information	Network monitor & network manager
Copenhagen smart destination	Network monitor & network manager

Combinations of intermediary roles summarised

Governance

Both public and private parties fill the intermediary roles

Finally, it is interesting to see the governance of the intermediary roles. In other words, who fills which role(s)? Experience shows that intermediary roles have been filled in both public, private and public-private terms (see table below). There has been a preference to fill the network monitor role publicly and the assessor role privately, but not so much a preference for the network manager role. And in principle, all public and private parties participate at the strategy table; both public- and private parties have chaired the strategy table.

Pilot site / use case combination	Public	Private	Public-private
Amsterdam network optimisation	Network monitor	Assessor	Strategy table (private chairmen) Network manager
Amsterdam smart destination	Network monitor Network manager		
Antwerp network optimisation	Network monitor	Network manager *Assessor*	*Strategy table*[13] *(public chairman)*
Copenhagen network optimisation / environmental zone information		Network monitor Network manager	*Strategy table*[13] *(private chairman)*
Copenhagen smart destination		Network monitor Network manager	
Road works[14]		Network monitor	

Governance intermediary roles summarised

Conclusions

In summary, the comparative analysis at cross pilot level shows that the cooperation framework created in SOCRATES[2.0] is important; it is a kind of language that both public and private parties have learned to speak and trust. The cooperation framework does not in itself create cooperation, but it does facilitate it. Many partners emphasise that this is very valuable. Compared to the upfront expectations in the ex-ante evaluation, the comparative analysis at cross pilot level shows that it is not so much that one cooperation model as such is more effective than the other one, but that one cooperation model is more appropriate for a type of use cases than another[15]. New within SOCRATES[2.0] is interactive traffic management, which is mainly expressed in the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/service providers to increase impact. For such a type of use cases, a *coordinated approach* is appropriate and to some extent necessary. At the same time, this cooperation model is quite complex and not immediately feasible in all pilot sites. Because the choice for a cooperation model is also determined by the regional context (starting position). *'It is hardly possible to jump to a coordinated approach all at once'*, an interviewee summarises. Having the essentials of *exchanged data* forms the basis for the other two cooperation models. This endorses the importance of relating the role of a national access point to the cooperation framework.

The comparative analysis at cross pilot level also shows that the associated intermediary roles are part of the functioning of the entire traffic information and navigation services value chain. Compared to the upfront expectations in the ex-ante evaluation, indeed both public and private parties fill the intermediary roles. However, in view of the desired neutrality it is not always sensible to combine the assessor role with another one. At the same time, SOCRATES[2.0] has not yet been able to fully demonstrate how the intermediary roles work precisely in their mutual interaction.

[13] In the Antwerp region and the Copenhagen region, the strategy table has been organised informally and pragmatically (no initially part of the pilot design).

[14] With regard to the governance of the intermediary role, the pilot site / use case combinations for the Amsterdam region, Antwerp region and Copenhagen region for road works are comparable.

[15] The type of use cases is related, among other things, to the ambition and expected impact to be generated.

3.2 Analysis technical performance

Technical conduct

Technical stability is more than sufficient

The technical stability of the traffic management and navigation services chain, including the capacity to process data, is a precondition for interactive traffic management. In general, the comparative analysis at cross pilot level shows that both are more than sufficient. Each of the partners' subsystems showed no or limited downtime during testing, resulting in an average high technical stability (up to 100%). If minor problems already occurred, mainly at the start of the end-user services, these have been adequately resolved within an accepted timeframe. The same more or less applies to the capacity to process data.

Data availability

Most desired operational data are available, obtaining data to measure performance is still a challenge

The availability of the desired data is another precondition for interactive traffic management. A distinction can be made between operational data and data to measure performance. In general, the comparative analysis at cross pilot level shows that most desired operational data are available. However, obtaining data to measure performance is still a challenge. During the design of the use cases, an extensive process was done with the partners. So, before the start of the end-user services, a detailed description of the technical architecture and data requirements was made. This has been experienced as very useful for making agreements and identifying possible data gaps. However, not all data has been used; as explained in section 3.1, the partners tend to trust their own data more than to use the (merged and completed) view of the current traffic state created by the network monitor. Improvements also have been made to the more complex end-user services throughout the chain and, despite the extensive process, some ambitions had to be adjusted.

To some extent, SOCRATES$^{2.0}$ has been a catalyst for making public data available, whether or not through a national access point. An example is the environmental zone use in the Amsterdam region, where both static and dynamic environmental zone information is made available through the National Road Traffic Date Portal NDW (DATEX II RAZ profile). Another example is the smart destination use case in the Munich region, where the traffic management strategies for events in Messe München are made available through the National Access Point MDM. As explained in section 3.1, making traffic information available through a national access point has the great advantage that a wider range of automotive industry/service providers could also use the data feeds relatively easy in the future.

Some issues with regard to data reliability and data viability

In general, the comparative analysis at cross pilot level shows that no or hardly any issues with the reliability of the data have occurred. It is clear that having a common ground in data exchange is essential. There have been some issues in terms of the viability of the data. This concerns issues related to the view of the current (and predicted) traffic state and service requests, such as service requests that did not correspond with the view of the current traffic state or service requests that were sent at midnight when there was no traffic.

Data exchange

Standardisation should not be underestimated

Within SOCRATES$^{2.0}$, DATEX II has been used as standard for the exchange of traffic related information. The partners have made agreements about which data formats to use for which purpose. This so-called TMeX protocol includes all traffic related information that is exchanged between public traffic management centres, private back offices and intermediary roles, and is based as much as possible on existing standards (in addition to DATEX II also DVM Exchange).

As explained in chapter 2, the exchange of traffic related information is not new and DATEX II has also existed as a standard for some time now. However, a smooth data exchange is not always self-evident. This is confirmed from the comparative analysis at cross pilot level and applies to all pilot site / use case combinations. So, standardisation should not be underestimated. Experiences show that the job for interpreting the data standards has proved more difficult than expected. All partners agree that for a harmonised use of the standard for the exchange of traffic related information a next step is required.

Two main issues have arisen. The first issue has been caused by differences in data provision, as experienced in the road works use cases. The application of DATEX II (profiles) does not appear to be harmonised over all pilot sites. The network monitor has noticed how much shape and content differed per data source, data provider and even between the pilot sites. It also appears that the detailed information is not consistently added in the data format. The second issue has been caused by the different forms of georeferencing, as experienced in both the environmental zone information- and road works uses cases. It appears that data providers use different ways to describe environmental zones or road work with regard to the location reference. Map matching of the location references provided was not possible with enough accuracy.

Feedback loops are still operational to a limited extent

As explained in section 3.1, in none of the use cases it was possible to fully test the interaction between the strategy table and the assessor (feedback loop). This experience also translates into the data exchange, especially for the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/ service providers to increase impact. Not all ambitions for the implementation of systematic feedback loops from the end-user services have been achieved, mainly due to the lack of feedback data from the automotive industry/service providers and traffic management centres. In the end, limited feedback loops were implemented. As feedback loops are important – generating impact also means being able to monitor and assess that impact – more experiences need to be gained.

Conclusions

In summary, the comparative analysis at cross pilot level shows that a smooth data exchange is not yet self-evident. Having an European-wide standard in place to collect, exchange and use data throughout the entire traffic information and navigation services value chain is not yet enough. Compared to the upfront expectations in the ex-ante evaluation, the comparative analysis at cross pilot level shows that the technical stability is more than sufficient. And also the operational data availability is largely in order. However, the data exchange is a lot more difficult than expected. This has especially been experienced in issues with georeferencing and own interpretation of the standard. And also implementing feedback loops to improve quality and fine-tune algorithms also has been difficult, partly because obtaining data to measure performance is still a challenge.

3.3 Analysis functional performance[16]

Users and user satisfaction

SOCRATES$^{2.0}$ users' target largely achieved

The Grant Agreement specifies a target for the number of SOCRATES$^{2.0}$ users per pilot site. The comparative analysis at cross pilot level shows that this target has largely been achieved. The target number of SOCRATES$^{2.0}$ users has been met in both the Amsterdam and Antwerp region. For both the Copenhagen and Munich region, the lack of actual deployment due to the corona measures caused that these targets have not been met.

The number of agreed evaluation users has often not been achieved, which reduces the potential to quantify results. Both the number of SOCRATES$^{2.0}$ users and the number of evaluation users are shown per pilot site / use case combination in the table below. No users have been involved in the pilot site / use case combinations not mentioned.

Pilot site	Use case	SOCRATES$^{2.0}$users/evaluation users
Amsterdam region	Network optimisation	6.454 / 654
	Environmental zone information	135 / 0
Antwerp region	Network optimisation (variant II)	7.958 / 142
	Lane information	7.878 / 14
Copenhagen region	Network optimisation / environmental zone information	10 / 10

Number of SOCRATES$^{2.0}$ users and evaluation users (total for all automotive industry/service providers)

[16] A comment in advance, the main information presented in this section is based on the network optimisation use cases only, since for these use cases multiple automotive industry/service providers have recruited evaluation users. For two other use cases (environmental zone information in the Amsterdam region and lane information in the Antwerp region), evaluation users have been recruited by one service provider; if relevant, specific information with regard to these use cases is presented accordingly. For the smart destination use cases only a qualitative analysis has been executed using, amongst others, the data from the field tests with friendly users.

From the automotive industry/service providers information was obtained with regard to the development of SOCRATES$^{2.0}$ users over time. This information shows that for all automotive industry/service providers the number of SOCRATES$^{2.0}$ users was either stable or increasing over time during testing. This indicates that SOCRATES$^{2.0}$ users stayed on board the entire pilot period, being interested in both the pilot site and the end-user services provided. Two of the automotive industry/service providers have implemented the SOCRATES$^{2.0}$ information and advice into their existing services, allowing for a larger user base to be accessed (also for the ex-post evaluation). The two others opted for a dedicated implementation that required recruiting new users for their services. No differences in participation of the different setups has been found; it was only found that the recruitment efforts for new users did not result in higher numbers of users.

Fairly satisfied users

The evaluation users have been approached by the automotive industry/service providers with a questionnaire about the user satisfaction of the end-user service provided. It should be noted that for one service provider this question was asked before users experienced the end user service. The comparative analysis at cross pilot level shows that users are in general fairly satisfied, with a peak for the network optimisation use case in the Antwerp region (see table below). This peak can (most likely) be explained by the extra incentive by means of a toll-free voucher feature that was part of the end-user services. The relative low average user satisfaction in the Amsterdam region for two service providers is related to early adopters that experienced some start-up issues with wrong service requests and advices. Originally, the intention was to map the development of the user satisfaction over time in order to better understand the user satisfaction, but this information is not available due to various factors.

Road users use various sources for their travel- and traffic information

The questionnaires also provide more information about the road users' perspective on the developed end-user services in the travel- and traffic information landscape. Evaluation users have been asked, among other things, which information they trust. The comparative analysis at cross pilot level shows that evaluation users trust the information provided by the automotive industry/service providers more often as being true (compared to the information from the road authorities). Interestingly, this trust is not translated into a lower value or usage of other travel- and traffic information such as dynamic road signs. These dynamic road signs are valued (almost) as highly as the in-car information provided by the automotive industry/service providers. This can be explained by the fact that users for specific situations use specific sources (for example in case of incidents or road works), but also by the fact that users mix and match relevant information for their trip based on their experience. The only source that is less highly valued is the information provided by radio.

The evaluation users have also indicated that they see use cases / end-user services such as lane information and environmental zone information as an addition to the basic navigation services.

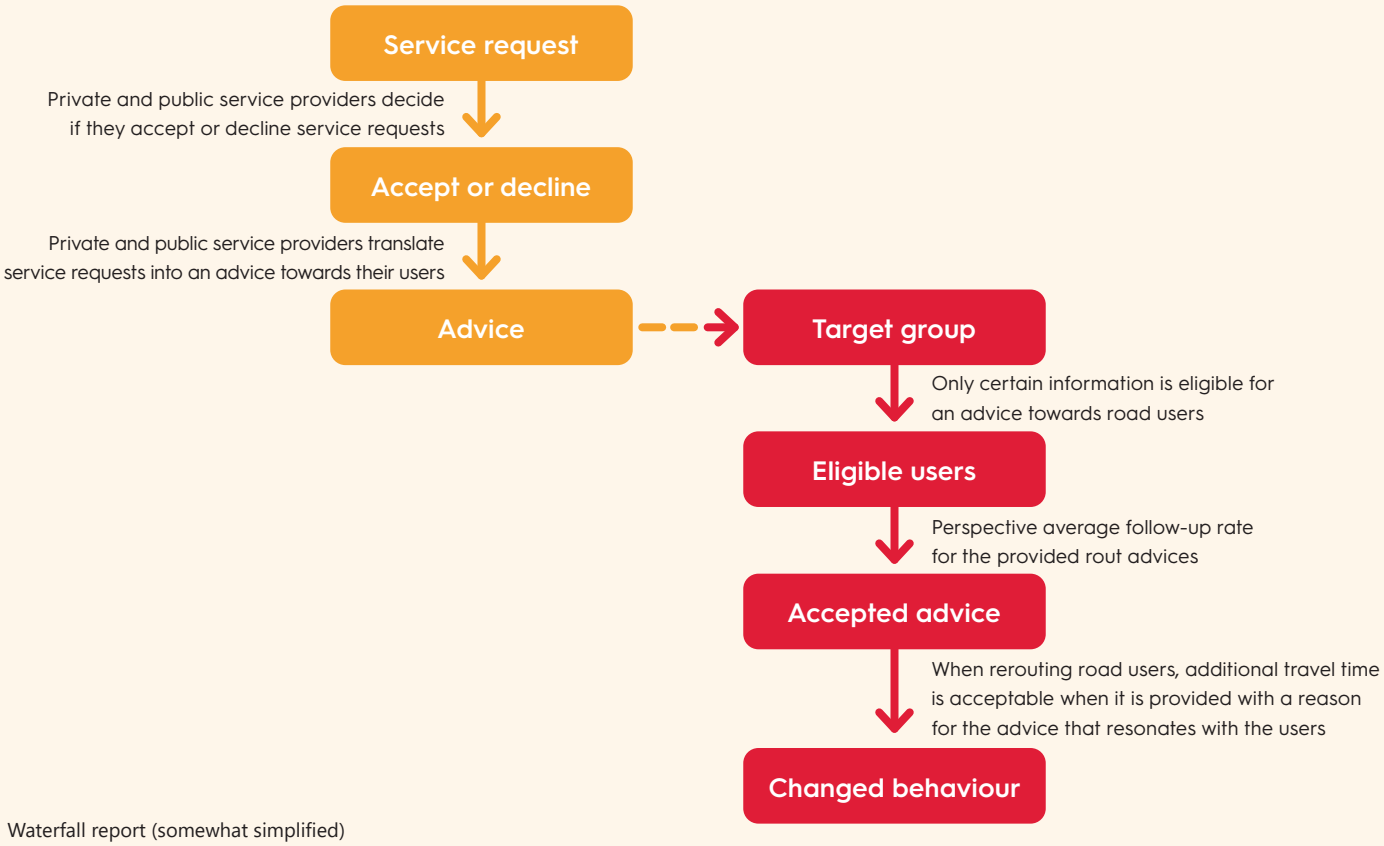
Pilot site	Use case	Average user satisfaction (ten-point scale)
Amsterdam region	Network optimisation	5.8 / 5.9 / 8.0 *(range three service providers)*
Antwerp region	Network optimisation (variant II) Lane information	9.4[17] 7.4
Copenhagen region	Network optimisation / environmental zone information	8.6

Average user satisfaction for evaluation users

[17] A score for the average user satisfaction is available for one of the two automotive industry/service providers.

From service request to impact on the road

The purpose of SOCRATES[2.0] is to make traffic smoother, safer and more sustainable. In other words, generating impact on the road through tailer-made advice towards road users. Within SOCRATES[2.0] the so-called waterfall report have been developed by the assessor to provide insight into the number of road users influenced by the advice from SOCRATES[2.0] (seer figure on next page). And thus in the impact that the automotive industry/service providers and traffic management centres (also seen as public service providers) generate, especially in the type of use cases in which the emphasis is on coordinating services by road authorities and automotive/service providers to increase impact.



Waterfall report (somewhat simplified)

Private and public service providers decide if they accept or decline service requests

It starts with the service requests themselves as an important factor to realise impact on the road. The automotive industry/service providers and traffic management centres decide if they accept or decline the service requests (sent by the network manager). During testing, it was found that both the quantity and the quality of service requests still needs attention, although improvements were seen towards the end. For example, the traffic management centres have disregarded certain service requests because they would contradict existing other traffic management scenarios. And because of the pre-processing by the automotive industry/service providers, the number of service requests translated into advice has been rather limited.

Private and public service providers translate service requests into an advice towards their users

The service requests are translated by the automotive industry/service providers and traffic management centres into an advice towards their users. For this translation, the automotive industry/service providers have used a set of internal parameters to determine which service requests would be relevant to which users. Think of the users' original route and destination and the additional travel time. The traffic management centres have used a similar analogy where the operators decide (after the automated first selection) whether service requests are used for activation of traffic management scenarios. In turn, the activation of traffic management scenarios leads to the provision of an advice towards all road users.

Only certain information is eligible for an advice towards road users

Using the follow-up percentage, the waterfall report provides more insight into the actual realisation of impact on the road. This starts with the step from 100% target group to the (non-) eligible users, and then the step to the acceptance and actual follow-up of the advice. From the data provided by the automotive industry/service providers, it becomes apparent that the key lays in the match between service requests and eligible users. For example, one of the service providers in the network optimisation use case in the Antwerp region has had a total of approximately 16.000 users in the Liefkenshoektunnel, but only 4.000 of these users were eligible for a toll-free voucher. The number of service requests processed by other service providers and the number of service requests translated into an advice have been all lower than the approximately 25%. From the traffic management centre perspective, a similar situation occurs when activating traffic management scenarios, since the displayed information us only relevant for a certain group of road users. So, to realise impact on the road a significant number of eligible users must be on the road.

Perspective average follow-up rate for the provided route advices

The comparative analysis at cross pilot level shows that the follow-up rate for the provided route advices in the network optimisation use cases, is in a range from 15% up to 57% (see table below)[18]. The service providers in both the Antwerp and Copenhagen region also provided insight into whether users actually changed their behaviour. These percentages are shown in the table between () behind the follow-up rate. As can be seen in the table, the acceptance of the advice did not per se result in actual change in behaviour. A detailed analysis from the service providers shows that users sometimes have taken a different route although accepting the advice or switched off the end-user service. As a result, the service providers have not been able to determine whether these users have indeed followed the advice. There is also no information available on any differences between specific groups of users.

When rerouting road users, additional travel time is acceptable when it is provided with a reason for the advice that resonates with the users

The service providers provided insight in the accepted additional travel time along with the accepted advice. The comparative analysis at cross pilot level shows that road users have been willing to accept additional travel time of up to 40 minutes, with the 96% of the accepted additional travel time being within 15 minutes. The reasons for accepting varies from the more personal oriented arguments (like avoiding congestion) towards more societal oriented goals (contributing to improvement of air quality).

Traffic effectiveness

No visible impact on the road, however there is a potential because road users are willing to change their behaviour

As expected upfront, the comparative analysis at cross pilot level shows that no actual traffic impact on the road has been measured. However, the follow-up of the advices does offer potential to optimise network traffic flow. In particular when taking into account the fact that road users are willing to accept a longer travel time. An important lesson from the network optimisation use case in the Antwerp region, is that with the right incentive users are willing to change their behaviour. The questionnaires also shows that even if only a reduction of the toll would be offered, still a significant number of road users are willing to change their behaviour.

Pilot site	Use case	Acceptance of service requests as percentage of follow-up
Amsterdam region	Network optimisation	20% / 30% / 38% *(range three service providers)*
Antwerp region	Network optimisation (variant II)	14% (6% change) / 48% *(range two service providers)*
Copenhagen region	Network optimisation / environmental zone information	57% (32% change)

Acceptance of service requests

[18] The follow-up rate is expressed as the percentage of users who accepted the advice provided by the automotive industry/service providers.

Conclusions

In summary, the comparative analysis at cross pilot level shows the positive impact of the SOCRATES$^{2.0}$ information and advice. The SOCRATES$^{2.0}$ users target has largely been achieved. Compared to the upfront expectations in the ex-ante evaluation, road users indeed positively appreciated the end-user services. They are willing to change their behaviour to some extent and to accept additional travel time when provided with a relevant reason. This creates a basis for realising impact on the road, for which the key lays in the match between service requests and eligible users on the road.

The comparative analysis also shows that bringing traffic management in car works and is appreciated by the road users for example by providing the reason with the advice. This is, from a road authority perspective an important first step towards bringing more traffic management services in car. This leads to the question if existing traffic management assets can be removed. Road users indicated they still use these assets on their trips to obtain relevant traffic- and travel information. It is unclear how users will respond if more and more traffic management information will be provided in car instead of at the roadside.

4. Evaluation of the maturity

To what extent is the concept of interactive traffic management as designed and tested in SOCRATES$^{2.0}$ already mature enough to be really deployed? This chapter provides an answer to this question.

4.1 The concept and its components

In the early stages of the project, the partners in SOCRATES$^{2.0}$ formulated a vision on the concept of interactive traffic management. The vision is elaborated along four elements: customer (road users), community, technology and cooperation. Looking back, the vision has mainly helped to build trust in the early stages of the project by giving guidance for defining pilot site / use case combinations to a certain extent. Loosely linked to this vison, the maturity of the concept of interactive traffic management has been evaluated for (see also table below):

- Public-private cooperation.
- Connecting traffic related information.
- Public acceptance and traffic performance.

Besides that, various components have been developed in such a mature manner that they will continue to be used beyond SOCRATES$^{2.0}$. This is an important legacy from SOCRATES$^{2.0}$ that should not be forgotten. In particular in the Amsterdam region, but also in the other pilot sites, components have been developed with a view to beyond SOCRATES$^{2.0}$. Think of the tilted table developed by the network monitor[19], the multimodal and other new parts of the network manager that are integrated in the traffic management software, and the waterfall report to gain insight into the follow-up of service requests developed by the assessor[20]. Other examples are the mechanism to share service requests with the automotive industry/ service providers and traffic management centres simultaneously, the so-called DATEX II RAZ profile for environmental zone information, and for example parts of the parking service developed by service providers.

Public-private cooperation

- Successful cooperation within the project offers potential
- Finding a win-win-win is still very difficult
- Cooperation framework is an important legacy from SOCRATES2.0
- More complex forms of cooperation are in their infancy
- Yet the cooperation framework is still difficult to explain to others

Connecting traffic related information

- From a technical perspective there is a solid foundation
- Making public data available does not guarantee that the automotive industry/service providers will use these data
- Standardisation of (the exchange of) traffic management related information is not as mature as often thought

Public acceptance and traffic performance

- Road users are willing to accept some additional travel time if it makes their trip more comfortable
- A limited number of the developed end-user services are mature enough to be deployed
- Realising traffic impact on the road requires a substantial user base with road users who actually change their behaviour

Overview of findings on evaluation of the maturity

[19] The tilted table combines public and private traffic related information per road section (instead of separate data feeds). In other words, the data made available is tilted; not the available data is the starting point, but the road section (location).

[20] The waterfall report provides insight into the number of road users influenced by the advice from SOCRATES$^{2.0}$ (see also chapter 3).

4.2 Public-private cooperation

Public-private partnership

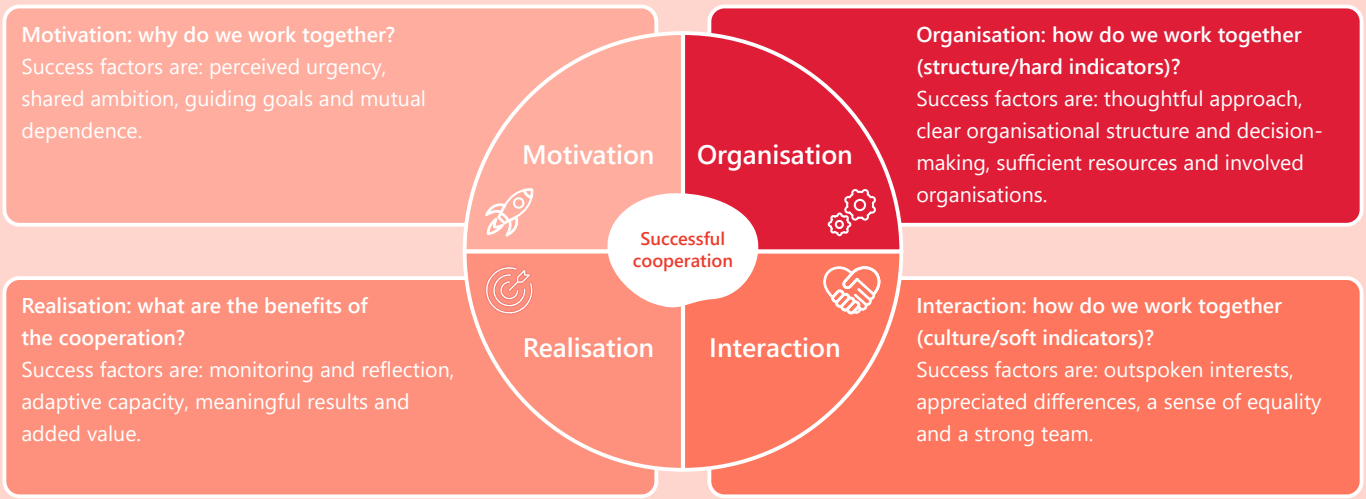
Successful cooperation within the project offers potential

The ex-post evaluation shows that the cooperation within the project has been successful. Looking from the four perspectives of the cooperation scan developed by TwynstraGudde, it is striking that the cooperation within the project scores high on 'how do we work together?'. Not only did the cooperation framework created in SOCRATES[2.0] helps to organise the cooperation, the partners also interacted with each other in a mature way within in the project (among other things in terms of atmosphere, openness and willingness). The partners appreciate the way in which they worked together, especially during the stage of the project in which the pilot site / use case combinations were designed; *'Everyone was able to contribute from their own world*'. The score on the realisation varies. On the one hand, the project has realised meaningful results for the partners; 85% of the partners (completely) agree with the proposition that SOCRATES[2.0] has realised meaningful results for their organisations (proposition scored by interviewees). On the other hand, designing has taken more time than expected. Because of this and the corona measures, the results of testing are sometimes somewhat disappointing. In particular, it has proved more difficult, also in relation to the motivation, to achieve a win-win-win (see the following).

Of course, the question is to what extent the built-up cooperation can be used European-wide. In that respect, especially significant is the finding that the cooperation framework created in SOCRATES[2.0] has contributed to the quality and maturity of the cooperation. It is precisely this finding that indicates the potential of a public-private partnership (see also the evaluation of the cooperation framework below).

Finding a win-win-win is still very difficult

The essence of the SOCRATES[2.0]' vision is that a sustainable cooperation needs a win-win-win for all stakeholders – road users, the automotive industry/service providers, and road authorities – in the traffic management ecosystem. The ex-post evaluation shows that the cooperation is not yet mature in this respect. Only 20% of the partners (completely) agree with the proposition that SOCRATES[2.0] has demonstrated that interactive traffic management realises a win-win-win (proposition scored by interviewees). In theory there is a win-win-win that is also endorsed by the partners, but in practice it is often still difficult to find that win-win-win. Only for the type of use cases in which the emphasis is on bringing traffic information in-car, a small win-win-win has been found in practice. For this type of use cases, the win-win-win balances out considering the limited efforts of road authorities to make data available and the limited efforts of the automotive industry/service providers to offer the end-user service on top of an already existing in-car service.



Cooperation scan developed by TwynstraGudde

But for the type of use cases in which the emphasis is on coordinating services by both road authorities and automotive industry/service providers to increase impact, SOCRATES[2.0] has not yet been able to demonstrate a way in which all parties in the ecosystem can benefit from it. It is still a challenge to demonstrate the (joint) ability to generate impact.

The cooperation framework created in SOCRATES[2.0] also has no clear relationship with the required public-private business model. An interviewee even calls it *'the elephant in the room'*, because without a sustainable public-private business model, end-user services will not be continued, even though partners are so benevolent. However, the business case elements may introduce a tension in an equal public-private partnership. Nevertheless, SOCRATES[2.0] has provided relevant insights to make the cooperation more mature in generating, assessing and rewarding impact:

- Governments play an important role in formulating societal goals, to which the automotive industry/service providers can contribute to. In practice, their (network) vision and goals seem to be leading.
- The traffic information and navigation services value chain can only be balanced if value/money passes through it. Although their business cases differ, it is often not enough for the automotive industry/service providers to simply cooperate with the system optimum by advising their users an alternative route that is not the fastest.

'*We are already familiar with public-private partnerships for data exchange. New within SOCRATES[2.0] is public-private partnerships as a way in which you can use private end-user services to pursue goals together. But that also includes the consideration that it is not so easy to find a way that benefits everyone. We sense that there is a lot of potential, but it is still really a challenge to find the right way to capitalise on it'*, an interviewee summarises.

Cooperation framework

Cooperation framework is an important legacy from SOCRATES[2.0]

The ex-post evaluation shows that the cooperation framework is an important legacy from SOCRATES[2.0]. According to 65% of the partners the cooperation framework is nicely put together. According to another 20% of the partners it logically fits with a continuous deployment of interactive traffic management (scored by partners during the evaluation session). *'You can really build on the cooperation framework'*, an interviewee summarises. So, it is not without reason that three-quarters of the partners see the cooperation models as a common framework for future public private cooperation. This common framework facilitates the dialogue on how to work together as road authorities and automotive industry/service providers in a new way; *'I think there is no other way. The cohesion of the road network and the required public-private partnership mean that cooperation will take place along the lines of these types of models*'.

More complex forms of cooperation are in their infancy

A deeper evaluation of the cooperation framework reveals that there is a difference in maturity between the use of the three cooperation models and the supported intermediary roles. The use of *exchanged data* is more or less business as usual nowadays. Though it still has its challenges, partners have sufficiently mastered this cooperation model.

New are the more advanced cooperation models *shared view* and *coordinated approach*. Within SOCRATES[2.0] important steps have been taken to test this level of cooperation, however more experiences need to be gained. The added value of the cooperation model *shared view* has not yet been clearly demonstrated. At the same time, there are opportunities where merging data can significantly improve the quality of data. Also more experiences need to be gained with the cooperation model *coordinated approach*. However, relevant insights are already:

- Cooperation does not start so much with shared goals as with the question how can we, even if public and private goals are different, agree on a joint strategy to optimise network traffic flow? Or even, how can the automotive industry/service providers contribute to societal goals? Some form of coordination of advice can be an opportunity for everyone.
- With regard to activating service requests (measures), it is interesting that the automotive industry/service providers highly trust on their own route-engines. They prefer service requests that allow the usage of their own route-engines rather than service requests that prescribe a route to be followed. Service requests should leave some degree of freedom to the automotive industry/service providers, allowing them to use their knowledge of traffic management and their users' behaviour to generate impact.

- As long as adjustments are not part of the question of the cooperation or the automotive industry/service providers are not actually rewarded for the impact they generate, there is no spontaneous interaction with the assessor. The same more or less applies to the traffic management centres.

The intermediary roles enable the interaction. The expectation of most partners is that public-private partnerships to a certain extent cannot do without the associated intermediary roles, at least for the moment. *'At the moment, in the transition we are working on and shaping the ecosystem, the intermediary roles are really needed'*, an interviewee explains.

Yet the cooperation framework is still difficult to explain to others

Creating the cooperation framework within SOCRATES$^{2.0}$ has been a joint journey. Each of the partners has mastered the cooperation models and the supporting intermediary roles. At the same time, experience shows that the cooperation framework is still difficult to explain to others. The cooperation framework has a degree of complexity in it that is not immediately understandable for everyone, especially if people are not involved in the project[21]. And perhaps some intermediary roles are only necessary in situations with many parties involved, such as in the Amsterdam region. In other regions it seems more evident for a party to fill a certain role. *'It's complex matter. The cooperation framework has been discussed in depth within SOCRATES$^{2.0}$; those involved have internalised it and are inspired by it. We can take advantage of it, but it is not that we expect it will be immediately embraced by others'*, an interviewee summarises the explainability.

[21] What can make it extra difficult is that people often think in terms of client – contractor (something that can easily arise around business case elements).

4.3 Connecting traffic related information

From a technical perspective there is a solid foundation

The ex-post evaluation confirms that the technical realisation of interactive traffic management is not the biggest challenge. From a technical perspective there is a solid foundation in terms of, for example, the technical stability of the traffic information and navigation services chain and the capacity to process data.

Making public data available does not guarantee that the automotive industry/service providers will use these data

On the one hand, the ex-post evaluation shows that not alle necessary data were available upfront. However, all desired data could be made available by the road authorities. Some steps have been made to standardise data – think of the environmental zone information that is made available according to the DATEX II RAZ profile – and adapt the data to the needs of the automotive industry/service providers. In principle, these data will remain available beyond SOCRATES$^{2.0}$, although not always through a national access point.
On the other hand, on contrary to popular belief, experience shows that making public data available does not guarantee that the automotive industry/service providers will use these data. Apart from the public-private business model, agreements must be made on, for example, adapting the data to the needs of the automotive industry/service providers, the service level and also the change process. Also in terms of data exchange, not all ambitions for the implementation of systematic feedback loops from the end-user services have been achieved, mainly due to the lack of feedback data from the automotive industry/service providers and traffic management centres.

Standardisation of (the exchange of) traffic management related information is not as mature as often thought

Within SOCRATES$^{2.0}$ DATEX II has been used as a standard for the exchange of traffic related information. But the ex-post evaluation shows that standardisation of (the exchange of) traffic management related information is not as mature as often thought. Even though DATEX II has existed as a European-wide standard for some time now, there is a lot of own interpretation and therefore ambiguity and miscommunication possible. For a harmonised use of the standard for the exchange of traffic related information a next step is required. The emphasis must shift from new functionalities to a solid application. This also includes

improving and integrating, where possible, the different forms of georeferencing. There is still a lack of a widely applied standard and accepted way of location reference. Even when a method for map agnostic location as OpenLR is used, there are still challenges to overcome to fully understand and apply this standard. Nowadays, an additional problem is that the required expertise is limited throughout Europe. Within SOCRATES$^{2.0}$ it has been demonstrated that a national access point can contribute to standardisation by, for example, making traffic related information available according to a European-wide standard.

4.4 Public acceptance and traffic performance

Public acceptance

Road users are willing to accept some additional travel time if it makes their trip more comfortable

The ex-post evaluation shows that road users who receive advice from SOCRATES$^{2.0}$, provided by the automotive industry/service providers, are willing to accept some additional travel time. However, it is important that the advice meets the right conditions; for example, it is important that it makes the trip more comfortable. Because the automotive industry/service providers are well positioned – trust in them is high – to identify which conditions resonate best with specific (groups of) road users, this can offer the potential to generate impact more efficiently (compared to traditional traffic management. More experiences need to be gained with the differences in behavioural change between different groups of road users. This is generally seen as an essential factor for public acceptance and thus for generating impact.

An important comment is that the win for road users has been based on the road authorities' vision, because road users themselves do not participate in designing the pilot site / use case combinations (in contrast to one of the principles in the SOCRATES$^{2.0}$ vision that the customer is in the loop). This could have been of additional value since road users, for example, could have requested different end-user services. It is important to realise that road users often see the different use cases developed as specific end-user services in SOCRATES$^{2.0}$ as one service from their service provider.

Traffic performance

Realising traffic impact on the road requires a substantial user base with road users who actually change their behaviour

Although the total number of SOCRATES$^{2.0}$ users is quite impressive, the ex-post evaluation shows that realising traffic impact on the road requires a next step to be taken. Realising this larger impact, it is necessary or understand how big the groups of road users are and whether these groups or road users can actually be reached. A survey study in the Netherlands[22] shows that in 2018 only 54% of the road users were connected while driving and thus could receive an advice to change their route. When this information is combined with the number of eligible users for a specific advice, it is clear that to generate impact on the road it is necessary to work together with (a consortium of) joint automotive industry/service providers.

[22] Rijkswaterstaat (2019), *Monitoring wegverkeer gerelateerde informatiediensten en rijtaakondersteunende systemen 2018.*

Potential of pilot site / use case combinations beyond SOCRATES[2.0]

Of course, the deployment of the end-users services is up to the automotive industry/service providers (and road authorities). Having said this, the ex-post evaluation shows that only a limited number of the developed pilot site / use case combinations are mature enough to be deployed. Given the importance of the regional context, a further distinction can be made between continuing an end-user service in the regions involved and rolling out an end-user service in other European regions. Most of the partners tend to agree that the developed end-user services are still on a demonstration level, although some end-user services can be rolled out in other European regions with some small adaptations. In summary, the intention of the partners is now to continue the end-users services related to the type of use cases in which the emphasis lays on bringing traffic information in-car. For the more complex end-user services where an advice, such as a reroute, must be provided, the intention is to further test a number of them. A number of others need further development for various reasons.

Intention to continue	Intention to test further	Need further development
Amsterdam environmental zone information	Amsterdam network optimisation	Antwerp network optimisation (variant II)
Antwerp network optimisation (variant I)	Amsterdam smart destination	Copenhagen network optimisation / environmental zone information
Antwerp lane information *(not only in the Antwerp region, but throughout Flanders and the Netherlands)*		Copenhagen smart destination Munich smart destination Road works

Overview of the potential of pilot site / use case combinations beyond SOCRATES[2.0]

5. Conclusions and lessons

SOCRATES$^{2.0}$ has tested to which extent the cooperation framework enables the deployment of interactive traffic management and whether innovative traffic information and navigation services are indeed emerging. This chapter presents the conclusions and lessons learnt, also in terms of scalability.

1. Parties in the ecosystem are open to cooperate; that is a profit in itself and partners have gained insights in what is important for successful cooperation.
2. SOCRATES$^{2.0}$ paves the way by providing building blocks and experiences for a future deployment of European-wide interactive traffic management.
3. Follow-up actions for making the concept of interactive traffic management sustainable are first and foremost related to finding a win-win-win.
4. Impact of interactive traffic management is highly dependent on the follow-up rate and user base.
5. Within SOCRATES$^{2.0}$ each use case implementation has unique features making actual scalability a challenge.
6. A well worked-out cooperation framework is essential in interactive traffic management; what could each of the partners receive in and contribute to the cooperation?
7. Deploying interactive traffic is much more than scaling up an innovation, it also requires some mind-shift about the traditional roles among parties in traffic management.
8. Data exchange is precondition for upscaling; for this, the emphasis should be on aligning the use of existing DATEX II formats and implementing feedback loops.

Overview of conclusions and lessons learnt

5.1 SOCRATES$^{2.0}$ and beyond

Major changes take place step by step. Partners consider SOCRATES$^{2.0}$ to be one of the first steps towards the future of interactive traffic management. The purpose is to make traffic smoother, safer and more sustainable, in accordance with the recent European *Sustainable and Smart Mobility Strategy*. Important insights and lessons have been gained. In part, these lessons could only be learned because several use cases have been designed and tested using different cooperation models in four European urban regions with each their own characteristics.

1. Parties in the ecosystem are open to cooperate; that is a profit in itself and partners have gained insights in what is important for successful cooperation

New élan in the field of traffic management is only possible if public and private parties work together as equal partners. Viewed in this way, the fact that parties in the ecosystem are open to cooperate is a profit in itself. *'Each of the parties have been able to contribute from its own perspective and to learn from the other and its perspective. I think that is important for future public-private cooperation*', an interviewee says appealing. Partners have been somewhat pleasantly surprised by the openness in the international setting and the willingness to experiment with working together in a new way (within the boundaries of the project). This may have to do with the conviction of partners that coordination in traffic management seems promising for all parties. In each case, public and private parties now understand each other better and a start has been made with in-depth knowledge of each other's perspective.

2. SOCRATES$^{2.0}$ paves the way by providing building blocks and experiences for a future deployment of European-wide interactive traffic management

SOCRATES$^{2.0}$ confirms that you can move forward with new and extended traffic management measures and in-car services for road users by making systems in-car and at the roadside to work together. SOCRATES$^{2.0}$ provides a new cooperation framework for a well-structured cooperation between road authorities, automotive industry and data- and service providers. This building block is the main legacy. SOCRATES$^{2.0}$ also provides relevant experience in bringing traffic information in-car, jointly improving traffic information by merging public and private data and – and that is new – coordinating services by both road authorities and the automotive industry/service providers to increase impact.

Besides that, various components have been developed that will continue to be used beyond SOCRATES$^{2.0}$.

3. Follow-up actions for making the concept of interactive traffic management sustainable are first and foremost related to finding a win-win-win

A future deployment of European-wide interactive traffic management is a path whose end has not yet been reached. Several challenges still need to be overcome. *'We all (still) see the potential and we have taken serious steps forwards; we have building blocks and indications of the added value. But it is not yet mature enough to deploy'*, an interviewee summarises.

These challenges are first and foremost related to finding a win-win-win: a win for road users, a win for the automotive industry/service providers and a win for road authorities. *'Before you as partners start a business that offers interactive traffic management, you would like to have more tangible results to show why that is a good idea'*, an interviewee makes clear. It is about actually generating and demonstrating/monitoring impact. The added value for all parties in the ecosystem has not been sufficiently clarified. Therefore there is also a limited view on how the public-private business model could look like. The idea of for example an impact driven business model is promising but needs further exploration. Exactly how much impact can be generated, how much value does that have and how to monetarise that value[23], who has the costs and benefits, how do you avoid an old-fashioned client-contractor relationship, and so on. Other challenges relate mostly to creating the conditions for cooperation and exchanging data.

[23] One value could be that road authorities can partly replace the current systems at the roadside, which are expensive to maintain, with private end-user services. Road authorities can then partly reinvest the savings they realise in a reward system for the automotive industry/service providers for the generated impact.

Challenge evaluation scalability

To evaluate the maturity, the partners worked during the evaluation session on a challenge of implementing interactive traffic management in another European region. As a thought experiment, the partners had to prepare a presentation for the board of the region, based on what they have learned about achieving SOCRATES[2.0] goals. The results show that the deployment of interactive traffic management is a combination of process and content, in which the regional context also plays a role:

- *Process*; interactive traffic management starts with interaction. '*There is a lot of interaction in the initiation phase; interactive traffic management is really co-creating.*' It is not just about choosing a cooperation model and specifying the (intermediary) roles. For example, there are also questions about procurement and (im)possibilities for entering new partners.
- *Content*; interactive traffic management opens doors to innovative traffic information- and navigation services. It is about making an inventory of the problems in the region, selecting use cases, specifying the data interface and providing the functional design.

While there are still a number of challenges, partners are enthusiastic about the possibilities to implement interactive traffic management in other European regions.

5.2 Impact of new and extended traffic management measures and in-car services

4. Impact of interactive traffic management is highly dependent on the follow-up rate and the user base

The impact of interactive traffic management is highly dependent on two main factors, knowingly the follow-up rate of route advices by specific groups of road users and the use base. The latter involves both the access of the automotive industry/service providers to these road users and the number of eligible users who are on the road when a service request is activated. The tailoring of end-user services allows for an increase in the follow-up rate since users are sensitive for different incentives that can be part of the advice. Within SOCRATES[2.0], it was shown that approximately one third of the advices provided by the automotive industry/service providers has been accepted by users. For scaling-up the end-user services a next step in the number of road users that can be reached is necessary

to realise real impact on the road. Not only due to the timeframe of the service requests (running at specific moments in time) but also in relation with road users who need to change their behaviour to actual generate impact.

Within SOCRATES$^{2.0}$ the use cases defined were based on a general understanding of the goal and the impact that was meant to be realised. During the project this generic description was implemented in the various pilot sites taking the specific regional contexts into account. The effort necessary for the specific implementations proves that actual scalability is complex since no two implementations are the same and thus this effort is necessary every time when a service is implemented in a new location.

5. Within SOCRATES$^{2.0}$ each use case implementation has unique features making actual scalability a challenge

The end-user services deployed in the different pilot site / use case combinations have been tailor-made. Each use case implementation has unique features making actual scalability a challenge, because the necessary effort would be required every time an end-user service is deployed in a new region. However, the key in interactive traffic management lays in exchanging data and especially coordinating goals that parties jointly want to reach on the road network. To be able to make this work, the parties need to trust and accept the view of the current and predicted traffic state and the service requests. More concretely this boils down to the quantity and quality of the service requests that need to be consistent and not contradicting earlier statements. SOCRATES$^{2.0}$ shows that good progress has been made, but further development is essential to be able to scale these end-user services European-wide.

5.3 Usefulness cooperation framework

6. A well worked-out cooperation framework is essential in interactive traffic management; what could each of the partners receive in and contribute to the cooperation?

The cooperation framework created in SOCRATES$^{2.0}$ enables a well-structured cooperation between road authorities and the automotive industry/service providers. The cooperation framework consists of three cooperation models with supporting intermediary roles: *exchanged data, shared view* and *coordinated approach*. Although the cooperation models have been created in such a way that they can be used in any region, when scaling up, it is important to realise that the choice for a cooperation model is also determined by the regional context. Before scaling up, it is still important to gain more experiences with the more advanced cooperation models, especially with a *coordinated approach*.

A specific topic of interest is the question on how the cooperation models relate to today's procurement legislation. Within SOCRATES$^{2.0}$ road authorities and the automotive industry/service providers have worked together as equal partners. A co-funding regime has enabled and kick-started the governance of the consortium. However, this has only been possible between the boundaries of the project. Although it is not a topic of research within the project, partners expect that the current procurement legislation may not fit when scaling up.

7. Deploying interactive traffic management is much more than scaling up an innovation, it also requires some mind-shift about the traditional roles among parties in traffic management

Deploying interactive traffic management is much more than scaling up an innovation. The concept of interactive traffic management is also shaking up current practice. Successful upscaling requires some mind-shift about the traditional roles among parties in traffic management. The role of both road authorities and the automotive industry/ service providers is changing. Governments play still an important role (in formulating societal goals), SOCRATES$^{2.0}$ shows again. Achieving these goals does not only require a network approach and access to data from multiple sources. SOCRATES$^{2.0}$ shows that the automotive industry/ service providers can also make an important contribution to societal goals. So, road authorities need the automotive industry/service providers and have to work together equally; not only with individual private parties, but also with joint parties. In short, the role of road authorities is shifting to a certain extent from managing by themselves to creating conditions with which the automotive industry/service providers may 'use' the road network and guide road users over it.

SOCRATES$^{2.0}$ shows that the change is equally great for the automotive industry/service providers. The challenge for them is to actually contribute to societal goals; what impact can they generate and demonstrate? As stated before, the idea of for example an impact driven business model is

promising but needs further exploration. So, the role of the automotive industry/service providers also needs to shift to a certain content. It requires that they consider their own role in the cooperation with road authorities and the division of roles between them.

8. Data exchange is a precondition for upscaling; for this the emphasis should be on aligning the use of existing DATEX II formats and implementing feedback loops

Data exchange is a precondition for upscaling interactive traffic management, but SOCRATES$^{2.0}$ shows there is currently no generic solution for the exchange protocol for traffic management related information between public traffic management centres and private back offices. The emphasis should be on aligning the use of the existing DATEX II formats (thorough and harmonised application). Three challenges for reaching this level of maturity are:

- *Standardising of traffic related information*; although DATEX II is a European-wide standard, in reality there is still a lot of ambiguity and miscommunication when exchanging data nowadays. A next step is required to reach a common ground in defining data structures and dictionaries on European level, as well as a harmonised use of this standard.
- *Making data available through a national access point*; subsequently making that data available through a (centralised or) national access point is important. As long as data are only available on a local scale, it is not easy for a wider range of automotive industry/service providers providing European-wide end-users services to use the data.
- *Organising change processes*; finally organising (scalable) change processes is important to harmonise changes in the common ground.

A specific topic of interest is the implementation of feedback loops, since generating impact also means being able to monitor and assess that impact.

5.4 Concluding

Major changes take place step by step. Partners consider SOCRATES$^{2.0}$ to be one of the first steps towards the future of interactive traffic management. Interestingly, the concept of interactive traffic management can also be (technically) combined with a multimodal approach. SOCRATES$^{2.0}$ confirms that interactive traffic management starts with cooperation. Interactive traffic management is first and foremost human work, where learning to speak a common language and creating trust between partners are essential. Then, of course, it is important to do justice to the interests of road authorities and the automotive industry/services providers and find out what they could contribute to the ecosystem of interactive traffic management.

'The real challenge is to demonstrate that there is added value for all partners'

As stated before, several challenges still need to be overcome. These challenges are first and foremost related to finding a win-win-win. But partners are convinced that at some point in time, the time is right to scale up.

Until then, there is the challenge of communicating SOCRATES$^{2.0}$ legacy to people outside the consortium and explain the potential of cooperation for future deployment of interactive traffic management. Partners are aware of this challenge and are looking forward to liaise with interested parties; *'We shouldn't keep it inside, others should also be able to think along*'.

Appendix: comparison ex-ante evaluation

Organisational performance

To research	Upfront expectations	Results
Cooperation on strategic level		
Agreement on joint network strategy to optimise network traffic flow	Public and private parties are able to agree on joint strategy to optimise network traffic flow	Cooperation on a strategic level does not start so much with shared goals as with the question how can we, even if public and private goals are different, agree on a joint strategy to optimise traffic flow? Or even, how can the automotive industry/service providers contribute to societal goals? Governments play an important role in formulating these goals. In practice, their (network) vision and goals seem to be leading
Cooperation on tactical level		
Development tactical toolbox with defined measures	Public and private partners are able to develop tactical toolbox with defined measures	Interesting when cooperate on a tactical level is, with regard to activating service requests (measures), is that the automotive industry/service providers highly trust on their own route-engines. They prefer service requests that allow the usage of their own route-engines rather than service requests that prescribe a route to be followed
Activation defined measures	Public and private partners are able to activate defined measures	
Cooperation models		
Effectiveness cooperation models	So-called cooperation model *common truth* is more effective than *informing each other*	It is not so much one cooperation model as such is more effective than the other one, but that one cooperation model is more appropriate for a type of use case than another. For a type of use case in which the emphasis is on coordinating services by both road authorities and automotive industry/ service providers a *coordinated approach* is appropriate and to some extent necessary
	Effectiveness cooperation models depends on type of use cases and differences between pilot sites	The choice for a cooperation model is not only determined by the type of use cases, but also by the regional context (starting position)
Interpretation intermediary roles	Public and private parties each fill (part of) intermediary roles	Both public and private parties fill the intermediary roles. However, in view of the desired neutrality it is not always sensible to combine the assessor role with another one

Comparison with upfront expectations ex-ante evaluation cooperation

To research	Upfront expectations	Results
Road authorities' role		
Changes in road authorities' role Added value information from private parties in traffic management centres	Public parties continue to control Road operators will work on more tactical level Road operators have to manage more different information types Public parties integrate private data into traffic management processes	Deploying interactive traffic management is much more than scaling up an innovation. The concept of interactive traffic management is also shaking up current practice. Successful upscaling requires some mind-shift about the traditional roles among parties in traffic management. The role of both road authorities and the automotive industry/service providers is changing. Road authorities need the automotive industry/ service providers and have to work together equally; not only with individual private parties, but also with joint parties. In short, the role of road authorities is shifting to a certain extent from managing by themselves to creating conditions with which the automotive industry/service providers may 'use' the road network and guide road users over it
Automotive industry/service providers' role		
Changes in automotive industry/service providers' role Added value of information from public parties in devices	- -	The change is equally great for the automotive industry/ service providers. The challenge for them is to actually contribute to societal goals; what impact can they generate and demonstrate? So, the role of the automotive industry/ service providers also needs to shift to a certain content. It requires that they consider their own role in the cooperation with road authorities and the division of roles between them

Comparison with upfront expectations ex-ante evaluation cooperation (continuation)

Technical performance

To research	Upfront expectations	Results
Technical stability		
Technical stability chain to deliver services Capacity chain to process data	System is 95% of time in condition to deliver end-user services System is 95% of time in condition to process data on time	The technical stability of the traffic management and navigation services chain, including the capacity to process data, is more than sufficient. Each of the partners' subsystems showed no or limited downtime during testing, resulting in an average high technical stability (up to 100%)

Comparison with upfront expectations ex-ante evaluation technical conduct

To research	Upfront expectations	Results
Required data		
Gap between desired and available data	Insight into desired and available data Private parties make 80% of desired data openly available	A distinction can be made between operational data and data to measure performance. In general, most desired operational data are available. However, obtaining data to measure performance is still a challenge
Data exchange		
Data collection, aggregation, merging and completion	Public and private parties are able to collect, aggregate, merge and complete data in accordance with agreements	Public and private parties are able to collect, aggregate, merge and complete data in accordance with agreements. However, not all ambitions for the implementation of systematic feedback loops from the end-user services have been achieved, mainly due to the lack of feedback data
Data standards needed for data exchange	DATEX II is suitable as data standard for data exchange	DATEX II is suitable as data standard for data exchange. However, the data exchange is a lot more difficult than expected. This has especially been experienced in issues with georeferencing and own interpretation of the standard. So, standardisation should not be underestimated
Reliability data		
Data quality	Insight into quality of data	In general, no or hardly any issues with the reliability of the data have occurred. It is clear that having a common ground in data exchange is essential. There have been some issues in terms of the viability of the data. This concerns issues related to the view of the current (and predicted) traffic state and service requests
Added value social data	More than 50% of data has added value	*No information available*
	Social data is used in different use cases to inform road users	*No information available*
	Social data help to form communities	*No information available*
Stability data exchange	Data exchange is 95% of time in condition to deliver end-user services	The stability data exchange is more than sufficient. However, not all ambitions for the implementation of systematic feedback loops from the end-user services have been achieved
Algorithms		
Creation of optimising algorithms	Public and private parties are able to create algorithms for optimising network traffic flow	Public and private parties are able to create algorithms for optimising network traffic flow
	Optimising algorithms are sufficiently transparent	Optimising algorithms are not (sufficiently) transparent. There has been a gradual improvement of the network manager
Feedback loops	Public and private parties are able to organise feedback loops	In the end, limited feedback loops were implemented. As feedback loops are important – generating impact also means being able to monitor and assess impact – more experiences need to be gained

Comparison with upfront expectations ex-ante evaluation data management and quality

Functional performance

To research	Upfront expectations	Results
Participants		
Number of SOCRATES$^{2.0}$ users	At least 6.000 SOCRATES$^{2.0}$ users in Amsterdam region and 1.000 SOCRATES$^{2.0}$ users in the other regions	The SOCRATES$^{2.0}$ users target has largely been achieved
	SOCRATES$^{2.0}$ users stay during testing	For all automotive industry/service providers the number of SOCRATES$^{2.0}$ users was either stable or increasing over time
Participants' satisfaction		
(Change in) SOCRATES$^{2.0}$ users' satisfaction	SOCRATES$^{2.0}$ users appreciate personal advice positively	Users are in general fairly satisfied
	SOCRATES$^{2.0}$ users who follow-up personal advice are significantly more satisfied	*No information available*
Participants' follow-up behaviour		
Follow-up advice/use of information	-	The follow-up rate for the provided routes advices in the network optimisation use cases is in a range from 15% to 57%
Change in SOCRATES$^{2.0}$ users' behaviour	Sufficient SOCRATES$^{2.0}$ users change their behaviour	
Difference in change of behaviour of different groups SOCRATES$^{2.0}$ users	Insight into different groups users and their characteristics	No specific groups have been identified due to a low number of evaluation users. No significant differences have been found between the automotive industry/service providers
	Established communities make more use of end-user services	
Acceptation non-consistent information on the road and in-car	SOCRATES$^{2.0}$ users accept non-consistent information	Users have remarked that information provided should be correct, although no consistency issues have been found
	Insights into preference and why	
Factors that influence change behaviour, including financial incentives	Insight into factors influence change behaviour	The extra incentive by means of a toll-free voucher feature that was part of the end-users services in the network optimisation use case in the Antwerp region has been powerful

Comparison with upfront expectations ex-ante evaluation user acceptance

To research	Upfront expectations	Results
Traffic distribution over road network		
Degree of distribution over road network	Traffic is better distributed over road network	No actual traffic impact on the road has been measured. However, there is a potential because road users are willing to change their behaviour
Traffic management options		
Change of modality	-	*No information available*
Anticipation on traffic situations		*No information available*
Interpretation of environmental zones		*No information available*

Comparison with upfront expectations ex-ante evaluation traffic effectiveness

Appendix: insights from data collection for evaluation purposes

Data plays an important role in SOCRATES[2.0]. Not only for interactive traffic management itself – as stated before, a distinction can be made between operational data and data to measure performance – but also for evaluation purposes. For the evaluation of the technical- and functional performance in particular, a data plan has been drawn up with an overview of the required data. Based on this, agreements have been made with each of the partners about making these data available. An overview of the main insights gained from the data collection:

- *Balance between ideal-type and flexibility*; within SOCRATES[2.0], a distinction has been made between a minimum data set for evaluation purposes – based on the relevant evaluation aspects specified in an ex-ante evaluation – and other relevant data for further interpretation of the findings. One reason is that the end-user services have been implemented in the operational processes of the automotive industry/service providers. This partly determines which data reasonably can and cannot be expected. Another reason is the experience that flexibility is needed to respond to unexpected events (the coronavirus pandemic, some developments that turned out the be more difficult than expected, and so on).
- *Actual data collection takes time and energy*; although the data collection has been approached in a standardized manner (templates), it takes time and energy. A number of iterations have been needed to reach common understanding with all partners. For various reasons it sometimes proved difficult to make the complete minimum data set; partly because of the design of the end-user services, partly because of internal company regulations, and partly because of the general data protection regulation. The latter makes it especially difficult to evaluate/assess a rather essential element, namely the actual follow-up of the advice by road users.
- *Some data are difficult to compare*; what is striking is some data from the different automotive industry/service providers and traffic management centres are difficult to compare, despite all the time and energy that has been invested in it. (The reasons are similar to those in the previous insight). In particular, this insight is relevant for shaping future assessments of the generated impact.
- *Added value of interim analysis*; precisely because data collection is a challenge, it is important not to wait to analyse data until testing has been completed. For those pilot site / use case combination for which it was possible to do an interim analysis, such an analysis proved te be very useful. In discussion with the partners, the data collection was fine-tuned and additional data was sought that helped enrich the ex-post evaluation. For example, the follow-up behaviour has been further elaborated with alternative to upfront identified data that some service providers could make available.

SOCRATES 2.0

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Contact person
Evaluation team
Activity leader evaluation
henkjan.kwakernaat@rws.nl

TwynstraGudde ARUP Goudappel